



Fire Frequency and Black Carbon in Masticated Fuels

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I. Research Overview

Black carbon is an important contributor to long term carbon pools due increased resistance to decay. Recent studies evaluating effects of fuels reduction treatments and fires on stand level carbon dynamics have highlighted the importance of including black carbon in their estimates of stand level carbon. However, several questions exist regarding the long term fate of black carbon in managed fire ecosystems..

- Black carbon studies have yet to quantify production from specific fuel types, such as masticated beds
- Observational studies have found less-than-expected amounts of black carbon in soils given fire histories and measured black carbon production rates. Fire intensity and frequency likely control the amount of black carbon observed.
- Though subsequent fire has been suggested as a mechanism of black carbon loss, the rate of loss has yet to be experimentally quantified.
- Studies have found that the degree of thermal alteration is dependent upon fire temperature. Despite diminishing amounts of black carbon, repeated burning may increase black carbon recalcitrance



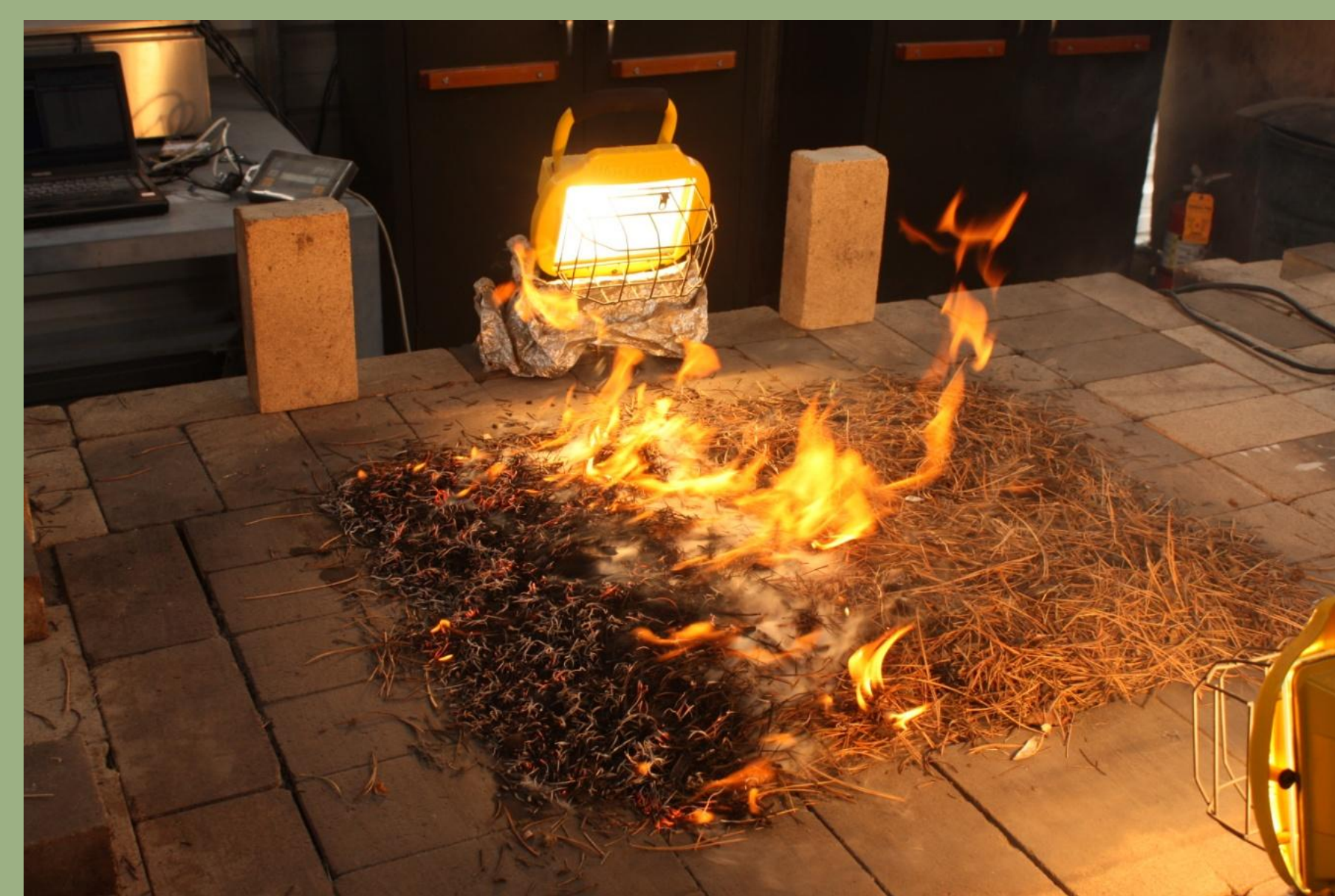
II. Experimental Burning Procedures



1) Fuel Characterization: Fuels were collected and sorted into 5 size classes. Mean weights for each size class were derived from 20 random field plots placed in masticated units on the Clearwater National Forest, Idaho.

2) Masticated Fuel Bed Creation: Fifteen identical fuel beds were created using the mean weight for each size class (litter, 0.3-0.6, 0.6-1.3, 1.3-2.5, and 2.5-7.6 cm). Fuels were mixed together and placed on the table.

3) Initial Burning Trials: Prior to ignition, fuel bed bulk density and fuel moisture were measured. During the fire, weather readings and flame height were recorded. A built in scale logged mass at 5 second intervals. The trial was complete when mass was no longer lost.



4) Post Fire: Burnt material was carefully removed from the table. Charcoal particles were then sieved to 0.3 cm. One gram of char was taken for black carbon analysis. The charcoal was then weighed and carried forward for repeated burning.

5) Fuel Beds for Repeated Burning: The remaining charcoal was mixed with approximated 0.7 kg of pine needles and placed on the back on the table.

5) Repeated Burning Trials: Each fuel bed was burnt a total of 5 times, for a total of 75 experimental burns. Procedures of charcoal sieving, subsampling, and weighing followed each fire.

III. Black Carbon Analysis*

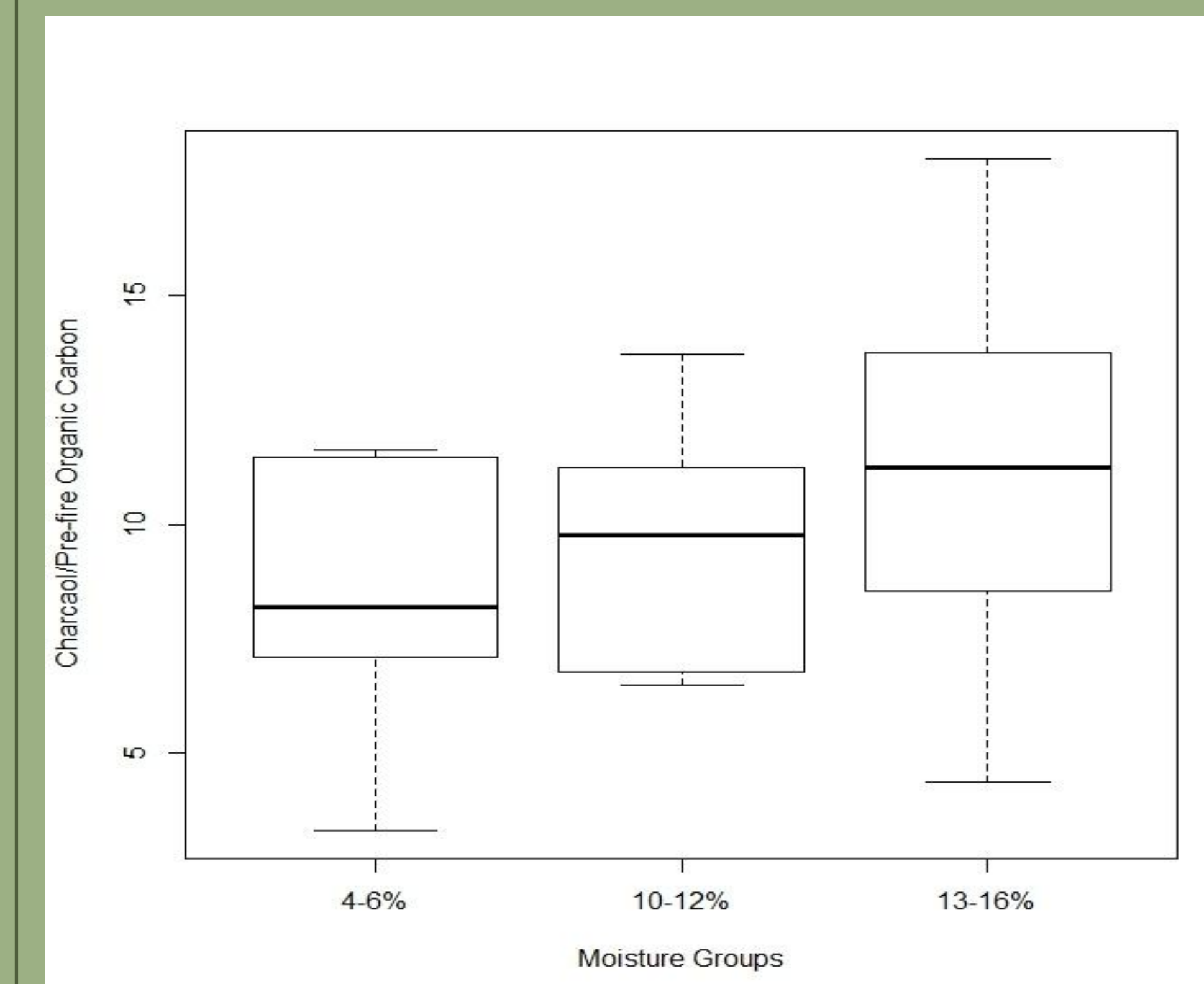
- 1) Samples (1g) from each of the 75 burns were milled and placed in a muffle furnace for 20 hours at 375°C to remove the organic carbon.
- 2) The remainder of the samples were then treated with 6N HCl to remove any carbonates
- 3) The samples were then placed in an elemental analyzer to determine %Carbon and Nitrogen. A mass spectrometer also recorded carbon isotope data as well.

4) Converting charcoal to black carbon:

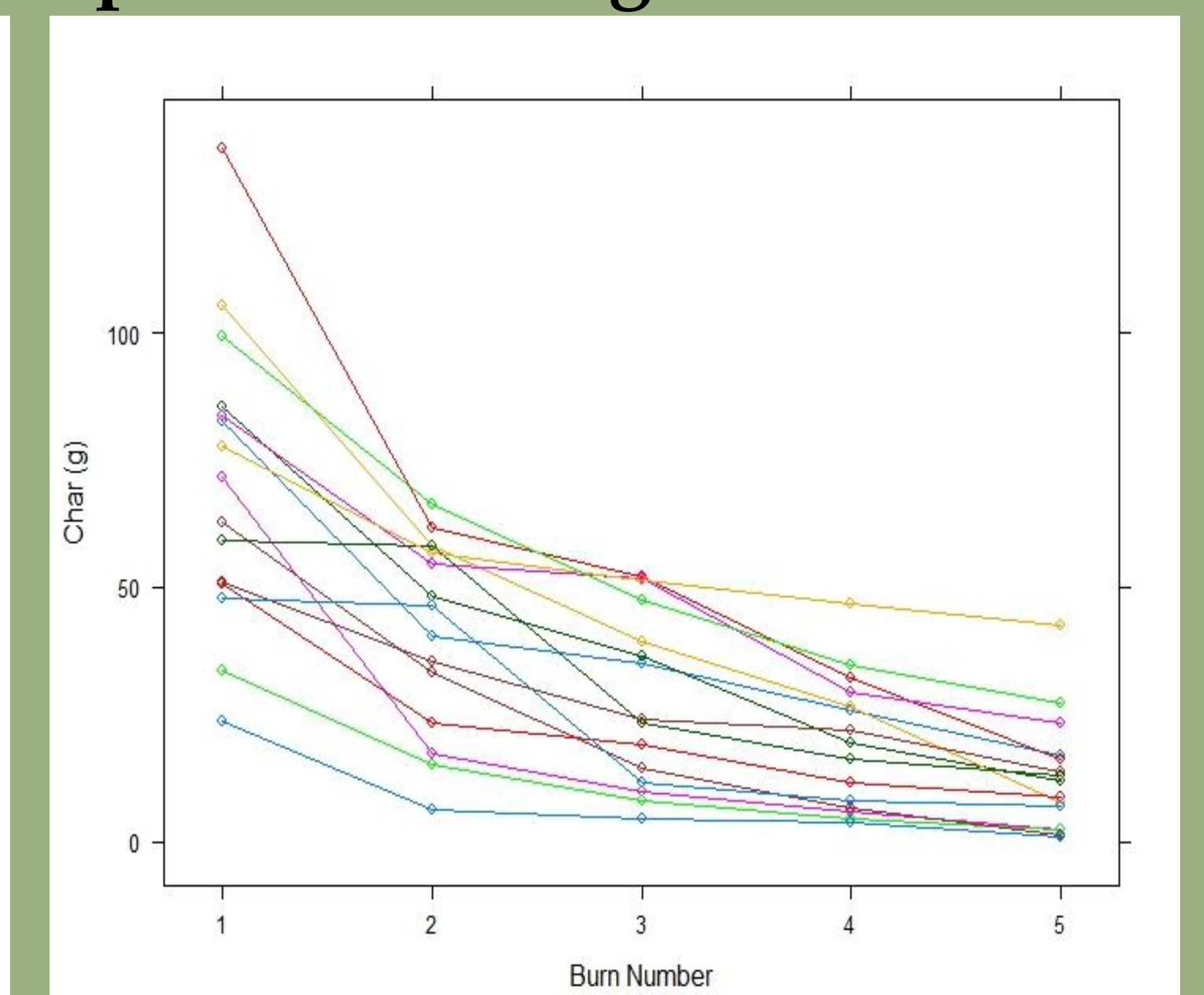
$$BC = \left(\frac{\text{Mass C}}{\text{Mass Following HCL}} \right) * \left(\frac{\text{Mass Following HCL}}{\text{Mass following muffle}} \right) * \left(\frac{\text{Mass of muffle sample}}{\text{Whole mass of dry sample}} \right)$$

*Methods were adapted from the CTO375 method described in Gustafsson (1997) and Hatten and Zabowski (2009). Several methods are available for quantification. Methods were chosen based on the high organic content of the samples.

IV. Black Carbon Production and Repeated Burning



Charcoal production as a function of moisture. No significant differences were observed in the ANOVA ($F=0.636$, $p=0.547$), but there is a slight increase in the amount of charcoal produced as fuel moistures increased. Numbers will be converted to black carbon values as %C data becomes available.



- Diminishing weight of charcoal through five repeated burns. Each line represents a separate fuel bed. Generally, a linear relationship is observed between separate burns and the charcoal produced.

V. Ongoing research and analysis:

-The inclusion of ambient conditions (temperature and RH), fuel characteristics (fuel moisture, bulk density), and fire behavior (see graph) will likely help explain some variability both between and within burn number.

-Isotope data will potentially help analyze effects of repeated burning on the “quality” of black carbon in both the initial burn and repeated fires.

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